

# BRITISH NEOCOMIAN RHYNCHONELLOID BRACHIOPODS

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## SYNOPSIS

A short stratigraphical account is given of the Lower Cretaceous, Neocomian beds of the southern part of the Lincolnshire Wolds. The Rhynchonellidae collected from these strata and beds of similar age in the northern Wolds, and from the Speeton Clay of Yorkshire are systematically described and compared with the corresponding fauna of the Brunswick and Hanover districts of north-west Germany, and also with faunas described from Neocomian horizons in Switzerland.

## INTRODUCTION

It was agreed at the Colloquium on the Lower Cretaceous held at Lyon, France in 1963 (p. 832) that the term Neocomian should not be used as a stage name, but that it should, perhaps, be preserved for a group of stages. It was further agreed that the term should be limited to represent three stages in the Lower Cretaceous namely, Berriasian, Valanginian and Hauterivian, and that the Barremian should be regarded as a separate stage midway between the top of the Hauterivian and the base of the Aptian.

It is difficult when dealing with older classifications and groupings of beds to be precise about the geological age. For this reason, and because the term Lower Cretaceous has a somewhat broader connotation, the term Neocomian as used in this paper sometimes includes reference to the Fulletby beds, generally regarded as of Lower Barremian age.

The material on which this paper is based was collected during the course of field surveys of the Lower Cretaceous rocks of the Lincolnshire Wolds, and from the cliff section at Speeton, Yorkshire. The descriptions of the formations in the

southern Wolds are taken from a thesis submitted and approved in 1957 for the degree of Ph.D. of London University by one of the authors (R.G.T.). Many of the species of Rhynchonellidae described here from the Speeton Clay and from the Claxby Beds of Nettleton, Lincolnshire, were collected by Dr. P. Rawson during his study of the northern Wolds for a thesis submitted and approved for the Ph.D. degree of Hull University in 1967.

Brachiopods appear sporadically throughout the British Neocomian but occur most frequently in the C<sub>6</sub>-D<sub>2</sub> Beds of Swinnerton at Speeton and in the condensed sequence of the Spilsby and Claxby series southeast of Nettleton. All the forms described here are from three main sources: Beds C<sub>6</sub>, D<sub>1-2</sub> of Speeton Cliff, Yorkshire; Claxby Beds at Nettleton, Lincolnshire [110980]; and the Roach Stone of the Fulletby Beds at Cawkwell [280880], Belchford [290750] and Dalby Park [410700], Lincolnshire. All National Grid references quoted fall within the 100 km. square TF.

Although the area occupied by the outcrop of the lower Cretaceous rocks in Lincolnshire far exceeds that of the Speeton Clay in Yorkshire, they have attracted much less attention. They are generally poorly exposed and even when brick-clay, iron-ore and building stone were being dug during the last century, useful occurrences were few and far between. Efforts to correlate the strata below the Red Chalk were at first attempted on rather tenuous geological evidence. Judd (1870) was the first to employ palaeontological methods, using the ammonites to compare the English facies with rocks at localities he had visited in Europe. A zonal standard of reference had not been established in any region at that time, but later research, mainly at Speeton, resulted in the publication of a zonal scheme based on the belemnites (Lamplugh 1889, 1924), which has remained in use until the present with only minor modifications (see Swinnerton 1936-55).

Lamplugh (1896 : 191-293) showed that the Speeton subdivisions were also recognizable in the Lincolnshire Neocomian, but other workers have preferred the more precise correlations afforded by the ammonite assemblages. Spath (1924) published a comprehensive system of zones for the Lower Cretaceous. Swinnerton (1935) recorded the presence of two additional ammonite faunas in the bottom three feet of the Spilsby Sandstone at Fordington Pumping Station [416714] Lincolnshire and added considerably to knowledge of the stratigraphy and faunas of the Neocomian of the southern Wolds. He proposed (1935, 1936) the lithological subdivisions adopted here, which embody the nomenclature originally proposed in the Geological Survey's memoir (Jukes-Browne 1887) but with further subdivisions inserted and the system of grouping the formations under geological headings extended. In the absence of borehole data, the thicknesses quoted in the following table have been assessed from field mapping, supported by aneroid traverses with allowances made for the effects of superficial movements, structural complications and facies changes.

The most complete and lithologically variable development of the Lower Cretaceous rocks crops out in the southern Lincolnshire Wolds between Fulletby and Spilsby. The general north-westward attenuation of the strata may be attributed to continued uplift of the Market Weighton Axis during Neocomian times with the consequent development of additional non-sequences and changes of facies towards

TABLE I

		Estimated thickness in feet		
		North		
		Willingham	Belchford	Dalby
Langton Series : Carstone Beds	Carstone Grit Carstone Sands and Clay Sutterby Marl	} 30	33	34
Tealby Series : Fulletby Beds	Upper Roach Roach Stone Lower Roach			
Tealby Beds	Upper Tealby Clay Tealby Limestone Lower Tealby Clay	} 27 20 60	70+	49
Claxby Beds	Upper Claxby Ironstone Hundleby Clay Lower Claxby Ironstone			
Spilsby Series : Spilsby Beds	Ferruginous Grit Glaucconitic Sands Basement Beds	} 35	70	60

that area. A number of interpretations of the detailed interrelations and variations of the formations in Lincolnshire have been published (e.g. Wilson 1948 : 54, Swinnerton & Kent 1949 : 73). From the present six-inch survey, the base of the Carstone Grit appears to overstep northwards all formations successively from the Sutterby Marl down to the base of the Upper Tealby Clay, as shown in Fig. 1. Thinning and change of facies within the Fulletby Beds in the same direction results in the disappearance of the Roach Stone north of Scamblesby [275788]. For the same reasons, the Hundleby Clay facies diminishes north-westwards and cannot be traced farther north than Belchford.

The typical lithologies of the strata from which many of the Rhynchonellidae described in this paper have been obtained are outlined below.

*Claxby Beds*

These beds, named from their well-known occurrence in the old ironstone workings [112963] near Claxby-by-Caister, were first described by Judd (1867 : 245; 1870 : 329) although Dikes & Lee (1837) had previously noticed a "ferruginous band" . . . at the . . . "top of the Green Sandstone" [= Spilsby Sandstone] at Nettleton.

Ferruginous and non-ferruginous lithofacies are distinguishable in Lincolnshire. The former is present in the northern and central Wolds as the Claxby Ironstone; south-east of Belchford [290750] both facies have been mapped, the non-ferruginous Hundleby Clay being recognizable as pale, purplish-grey, silty clay which splits the ironstone at about the middle and appears progressively to replace the lower part, until in the extreme south-east of the Wolds it comes to rest directly upon the Ferruginous Grit of the Spilsby Beds.

From a thickness of fourteen feet at Nettleton, there is no appreciable south-easterly thickening of the Claxby Beds at outcrop for twenty miles. At Harrington [365720] twenty-three feet are estimated to be present and almost thirty feet at



FIG. 1. Outcrop and sub-drift occurrences of the Lower Cretaceous rocks in east Lincolnshire and east Yorkshire.



Partney [410680]. The Hundleby Clay is estimated to be up to five feet thick at Belchford, fifteen feet at Hundleby [385640] and eighteen feet at East Keal [375645].

*The ironstone facies* is characterized by the ubiquitous presence, in varying concentrations, of oolitic iron ore embedded in pale-grey to dark-brown, ferruginous silty clays with pink or cream, calcareous, siltstone bands at some levels. These harder bands contain much less oolitic material than the clays, but both rocks may be hardened and secondarily enriched by ferruginous impregnation and by the oxidation of iron salts to limonitic material which occurs commonly as flaky aggregations in irregular veins and as encrusting "iron pan".

Glauconite is rare but polished well-rounded pebbles of chert and subangular quartz grit are found, especially about the middle and near the base of the ironstone. Beds of round phosphatic nodules up to four inches across may contain moulds of ammonites, belemnites and "steinkerns" of bivalves. These, together with frequent evidence of contemporaneous erosion, such as the presence of thin beds of broken shells and aggregations of broken and abraded ooliths resting on churned, uneven surfaces suggest that a number of minor non-sequences may exist. Clusters of brachiopods are found more commonly in the oolitic clayey seams than in association with other faunal elements, which appear to have flourished more persistently in the silty environments.

*The Hundleby Clay facies* normally comprises pale purplish-grey, mottled-brown, silty clay. It tends to become more arenaceous towards the top with yellow-stained shaly micaceous partings. At the type locality, near Spilsby, lenses of coarse, black, pyritous grit and others of white sand up to two inches thick and twelve inches long are present just below the Upper Ironstone, interbedded with irregular bands of decalcified, concretionary, buff-coloured siltstone nodules commonly traversed by irregular fractures infilled by ochreous ferruginous matter. At lower levels the Hundleby Clay characteristically contains less silt and, between Belchford and Hundleby itself, the whole thickness of the formation comprises unctuous, plastic clay wherever it is thick enough to be separately mapped. The sparse macrofauna appears to be devoid of brachiopods.

#### *The Fulletby Beds*

Formerly referred to by the Geological Survey as "The Roach" (Jukes-Browne 1887 : 19), the Fulletby Beds were first so called by Swinnerton (1935) from their obvious presence in the cliff-like feature which distinguishes the northern part of Fulletby Hill [300750], the type locality.

The formation is predominantly clayey, essentially ferruginous but rarely glauconitic, so that it is readily distinguishable in the Lower Cretaceous sequence. Exposures, though few, are usually of the Roach Stone. Characteristically reddish-brown clay loams are developed everywhere on these beds.

The Fulletby Beds were subdivided by Swinnerton (1935 : 4) as follows:

	Estimated thickness in feet	
	Fulletby/Belchford	Tetford/Harrington
Upper Roach	10-15	15
Roach Stone	4-6	15
Lower Roach	15-20	30

Of all the Lower Cretaceous rocks which crop out in Lincolnshire, these are probably the most variable in thickness and lithology. The clay or silty-clay matrix is commonly dark grey, though it may weather to brown and bright reddish-brown where concentrations of iron ore are particularly high. Grit grains and small rounded (lydite) pebbles are disseminated throughout. Churned horizons, as if brought about by contemporaneous erosion or by organisms, have been observed only rarely.

*The Roach Stone* crops out just above the middle of the Fulletby Beds, where the predominantly clayey sequence rapidly becomes sandy, somewhat less ferruginous and markedly more calcareous. At a higher level, the arenaceous nature of the Roach Stone is continued into the heavily ferruginous, silty Upper Roach.

The Roach Stone was originally described from the borehole at Alford (Swinnerton 1935 : 10) as a "hard calcareted ferruginous sandstone" approximately twelve feet thick. This description accords well with that given here for the sandstone facies at outcrop. The sandstone, however, is exposed infrequently and it is the ironstone facies which is seen at a number of localities over the whole area, and often it is the sole representative of the Roach Stone, especially in the ground northwest of Fulletby. These facts, especially the last, may suggest that the "ironstone" facies represents a lateral lithological development of the sandstone facies towards the northwest, as well as the indurated equivalent of those Roach beds which lie immediately above and below it in the southern part of the Lincolnshire Wolds. Accordingly, for practical reasons, the Roach Stone is here taken to include all the coherent strata at about the middle of the Fulletby Beds which give rise to mappable lithological and topographical features, irrespective of the previous lithological definition.

The ferruginous content of these beds is predominantly in the form of black or dark-brown polished oolites or limonite, although there is also a subordinate amount of amorphous and flaky ore, most of which appears to be secondary. The distribution of the indigenous limonite varies greatly; at the outcrop there is very little oolitic material in the Roach Stone or at the extreme base of the Fulletby Beds, but passing upwards in the Lower Roach, the oolitic content gradually increases to a maximum concentration in a bed just below the Roach Stone as defined by Swinnerton (1935) in boreholes. This rock is little more than a compact agglomeration of oolites with subordinate silty-clay matrix which has sometimes been made coherent at the outcrop by secondary "iron-pan" deposits, but which is more usually friable, and less sandy than Roach Stone. Above the Roach Stone the concentration of oolitic iron ore is high but it appears to decrease, and the fraction of the variegated clay and silty-clay to increase inversely, as the beds are traced upwards towards the base of the Sutterby Marl. At the base of the marl, however, the Upper Roach is again strongly oolitic in some localities (Cawkwell and Sutterby [385720]) but predominantly clayey at others (Dalby Park).

The Roach Stone occurs as two fairly distinct types; an earthy limonite rock and a calcareous sandstone. In the field, both rock types are recognizable in many small exposures, but it is not clear what the inter-relationship of these facies is, either in time or space. Both rock types may be examined in the same general area and both may be much disguised and hardened by secondary "iron-pan" deposits.



*The sandstone facies* is a hard fine-grained, yellowish-brown, evenly bedded siltstone or sandstone cemented by a ferruginous and calcareous ground-mass enclosing scattered grit grains and a few limonite oolites which are normally evenly distributed but may be more rarely confined to certain layers. The sandstone weathers along moderately strong, rectangular joints into flaggy fragments up to one foot square by about two inches thick, but more massive blocks can be picked up in ploughed fields. Fossils are extremely rare in this facies and no well preserved examples have been collected, but thin sections reveal a limited microfauna.

*The ironstone facies* is a soft, earthy rock with less sandy material and more oolitic limonite disseminated throughout than in the sandstone facies. It is also much more variable in lithology: primary calcitic cement may be unevenly replaced by tenaceous "iron-pan" and ferruginous veining which makes the collection and development of the sparse shelly fauna a tedious process; secondary calcite crystals may be present in cavities in the rock and encrust exposed blocks. With diminishing arenaceous content the ironstone facies tends to become even more strongly oolitic, softer, and to contain thin bands of broken shell debris, including disarticulated valves of brachiopods. This rock, when weathered, produces reddish-brown heavily ferruginous clayey loam, the true "roach" of the countryman, containing soft, crumbling boulders of ironstone from which a limited fauna of bivalves, belemnites and brachiopods has been recovered. In the Belchford-Fulletby districts, this facies of the Roach Stone also contain fragments of woody debris and peculiar root-like concretions ("fucoids") made of compact, silty ore.

Hitherto the Fulletby Beds have been regarded as being poorly fossiliferous, and indeed very few fossil genera have been recorded specifically from this subdivision of the Tealby Series. Of a number of brachiopods collected during the field survey, the Rhynchonellidae are now recorded and described for the first time from the English boreal Cretaceous. The brachiopod fauna from the Claxby Ironstone was described in part by Davidson (1874), and a revision of the Rhynchonellidae described by him is given here, with additional descriptions of species from a similar horizon in the Speeton Clay and from the Hanover district of north-west Germany.

#### SYSTEMATIC DESCRIPTIONS

Superfamily **RHYNCHONELLACEA** Schuchert 1896

Family **RHYNCHONELLIDAE** Gray 1848

Subfamily **CYCLOTHYRIDINAE** Makridin 1955

Genus **LAMELLAERHYNCHIA** Burri 1953

***Lamellaerhynchia rostriformis*** (Roemer)

(Pl. 1, figs. 1-6; Pl. 2, figs. 1-9; Pl. 3, fig. 2; Text-figs. 3, 4)

1836 *Terebratula rostriformis* Roemer : 40, pl. 2, fig. 22.

1839 *Terebratula multiformis* Roemer : 19, pl. 18, fig. 8.

1839 *Terebratula rostralina* Roemer : 20, pl. 18, fig. 7.

1841 *Terebratula multiformis* Roemer; Roemer : 37.



- 1842 *Terebratulula rostralina* & *rostrata* Roemer; Leymerie : pl. 15, fig. 11.  
 1863 *Rhynchonella multiformis* (Roemer); de Loriol : 113, pl. 15, fig. 23.  
 1864 "*Rhynchonella depressa* Credner" (in part); Credner : 549, pl. 18, figs. 5-12.  
 1871 *Terebratulula depressa* Quenstedt (*non* Sowerby, 1825); Quenstedt : 155, pl. 41, figs. 2, 6-10.  
 1872 *Rhynchonella multiformis* (Roemer); Pictet : 10, pl. 195, figs. 5-8.  
 1913 *Rhynchonella multiformis* (Roemer); Jacob & Fallot : 52, pl. 7, figs. 5-7.  
 1953 *Lamellaerhynchia multiformis* (Roemer); Burri : 275, fig. 2.  
 1956 *Lamellaerhynchia rostriformis* (Roemer); Burri : 652, pl. 7, figs. 1, 2, pl. 10, fig. 3.

DESCRIPTION. Biconvex *Lamellaerhynchia* varying from about 18-24 mm. long, 20-26 mm. wide and 12-15 mm. thick with a low median fold on the brachial valve and a correspondingly shallow sulcus in the pedicle valve. In some mature forms there is a marked tendency for the shell to become trilobate where the median fold is poorly developed. The uniplicate anterior margin shows some tendency to asymmetry and marginal thickening. The suberect beak is bordered by well-marked beak-ridges defining a broad, extensive interarea. Outward projections of the conjunct deltidial plates extend posteriorly and encircle a large foramen.

In outline the shell varies from subcircular to elongate-oval to broadly triangular. The umbo varies from short and massive to produced and sharp with incurvature of the beak. In the typical form, the ornament consists of twenty to twenty-four sharply defined, strong, radiating, non-bifurcating ribs on each valve with four to five on the fold and a similar number in the sulcus. In some of the variants the number of costae on each valve depends on the type of rib; some having fine, more rounded costae while others have more numerous but narrower, sharp ribs.

*Internal characters.* In the original description of the genus *Lamellaerhynchia* Burri (1953 : 276, fig. 3), included a series of thirteen transverse serial sections through the umbo of a specimen under the specific name of *L. multiformis*, from the Hilsconglomerat of Berklingen, Brunswick, north-west Germany, and added a further single section of another specimen from the Lower Hauterivian of Bachbett des Arnon, Switzerland. In a subsequent description of the genus Burri (1956 : 652, 655), correctly quoting the valid name for the type-species of the genus as *Terebratulula rostriformis* Roemer, included a further series of transverse sections of a specimen from Bachbett des Arnon, Switzerland.

Comparison of the series of transverse sections made by the authors from topotype material, and those made and published by Burri reveals fundamental differences which are recorded here. Although in general outline the umbonal cavities appear similar, the main differences lie in the distal ends of the hinge-plates which, in the specimen figured by Burri (1953 : 276) from Berklingen, are seen to have a concave dorsal surface and are, in the broadest sense, Y-shaped. The Swiss specimen which Burri (1956 : 655) subsequently figured is shown to have gently curving hinge-plates with no discernible division at the distal ends. The fourteenth section in the series showing the posterior ends of the crura is taken from the same specimen in each case, as admitted by Burri in the legend.

From this discrepancy in the description of the internal structure of *Lamellaerhynchia rostriformis* it must be concluded that Burri does not regard the shape of the hinge-plates as being of diagnostic importance, an assumption confirmed by his description of the genus which bears only a brief reference to that structure. The



writers, however, do not share Burri's view and include here a series of transverse serial sections (Text-fig. 3) of a specimen of *L. rostriformis* from Roemer's type locality of Elligser Brink, near Hanover, north-west Germany. It will be seen from this series that the dorsal surfaces of the distal ends of the hinge-plates are

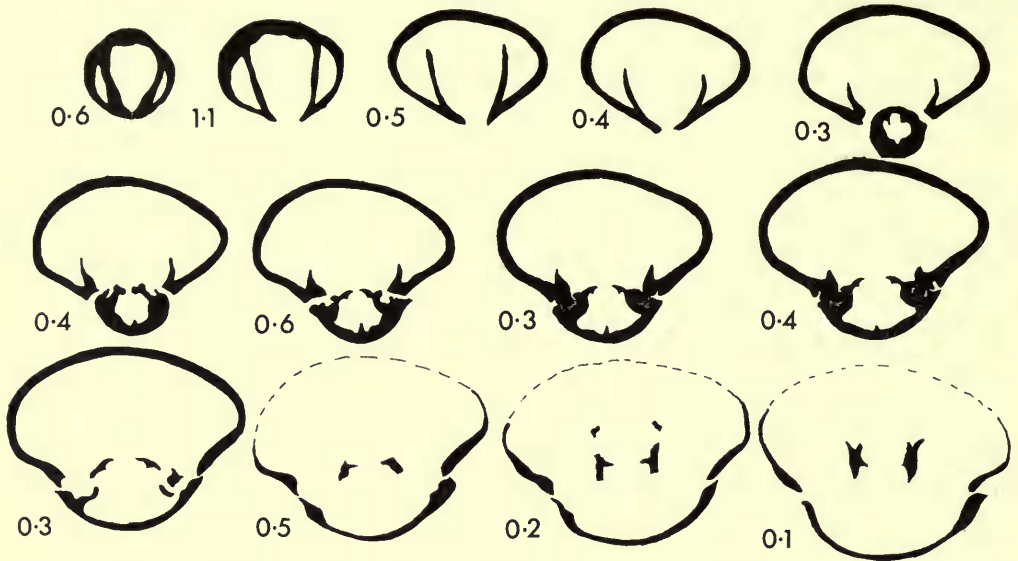


FIG. 3. A series of thirteen transverse serial sections through the umbo of a specimen of *Lamellaerhynchia rostriformis* (Roemer) from the Neocomian of the type locality at Elligser Brink, Hanover, Germany. B.35702.  $\times 2$ . Numerals denote distance in millimetres between each section.

concave or broadly Y-shaped (sections 8–10) and are, in fact, similar to those shown in Burri's original series (1953 : 276) from Berklingen. It may also be seen that the extreme posterior ends of the crura do not terminate in the manner of Burri's Swiss specimen i.e. acutely concave or U-shaped with the concave surface directed towards the floor of the dorsal valve. Instead they tend to narrow anteriorly, curving abruptly anteriorly with their concave surface both dorsally and ventrally directed. This stage is regarded as characteristic of *L. rostriformis* and may even be confined to this species since it is not shown in any of the transverse sections of other species of *Lamellaerhynchia*.

A specimen from Gros Vahlberg, north-west Germany (Text-fig. 4), preserved in a crystalline limestone matrix, shows this feature and once again demonstrates the concave surface of the ends of the hinge-plates. It should be noted that the dorsal median septum in this specimen appears more strongly developed and this may prove to be a variable character.

NEOTYPE. *Terebratula multiformis* Roemer 1839 is a synonym of the earlier *T. rostriformis* Roemer 1836, which therefore has priority and must be used even

though there is no evidence that Roemer ever used the name subsequent to 1836. The type material was housed in the Roemer Collection at the Hildersheim Museum, north-west Germany which was damaged and partly destroyed during the war (1939-45). In order to re-establish the species as *Lamellaerhynchia rostriformis* (Roemer), Burri (1956 : 653), selected a neotype from the remainder of the Roemer collection. This specimen, which he figured (Burri 1956, pl. 7, fig. 1 a-d) is in the Roemer-Museum at Hildersheim, registered number 781a. It is stated to have been collected from the " 'Hilston' (Astieria-zone = oberstes Valanginien oder Noricuszone = unterstes Hauterivien) " of Elligser Brink, near Hanover.

REMARKS. Roemer's original definition of *Terebratula multiformis* (1839 : 19, pl. 18, fig. 8) was so loosely expressed that it has hitherto been possible to include in it a large number of variable forms which, although they are doubtlessly closely interrelated genetically, may nevertheless be separated generically with advantage. Burri has found it practicable to differentiate between certain of these forms which are morphologically distinct in Switzerland and south-east France. He points out, however, that in north-west Germany the individual species of the genus *Lamellaerhynchia* are less distinct so that the amount of morphological variation produces transitional forms which cannot be assigned with certainty to any of the established species. This observation is reinforced by our experience with the comparatively few specimens collected from Lincolnshire and Yorkshire.

With such a variable species as *L. rostriformis*, and with so little material available from widespread localities, it is impossible to give any statistical data which would be of significance in determining the true morphological characteristics. Specimens collected from limestone localities, although in the main smaller, appear identical in every respect with those collected from the clays. Specimens collected from the Speeton Clay are comparatively rare, so a comparison has been made between limestone forms from Nettleton and those in a softer, more argillaceous, matrix from the " Elligser Brink Schiste " in the Hanover district of Germany. Likewise, specimens collected from limestone localities in Germany, such as Gros Vahlberg have been compared with similar forms from Nettleton in this country. In each case there has been perfect matching of both the typical form and intermediate variants.

From the foregoing description it may appear that such morphological differences in thickness, sharpness and number of costae, overall outline, produced beak and relative size might constitute an argument in favour of taxonomic separation, but no stratigraphical advantage is yet apparent. The variants described as having more numerous rounded costae, more produced beaks and more triangular outline could, perhaps, be referred to a subspecies, but the paucity of well-collected material from the Neocomian in this country and in north-west Germany makes such a separation difficult.

Burri (1956 : 695) does not record the geological range of this species, but it seems almost certain that the earliest record is from the Upper Valanginian and the latest from the top of the Hauterivian.

Jacob & Fallot (1913, pl. 7, figs. 5-7) figured three specimens under the name

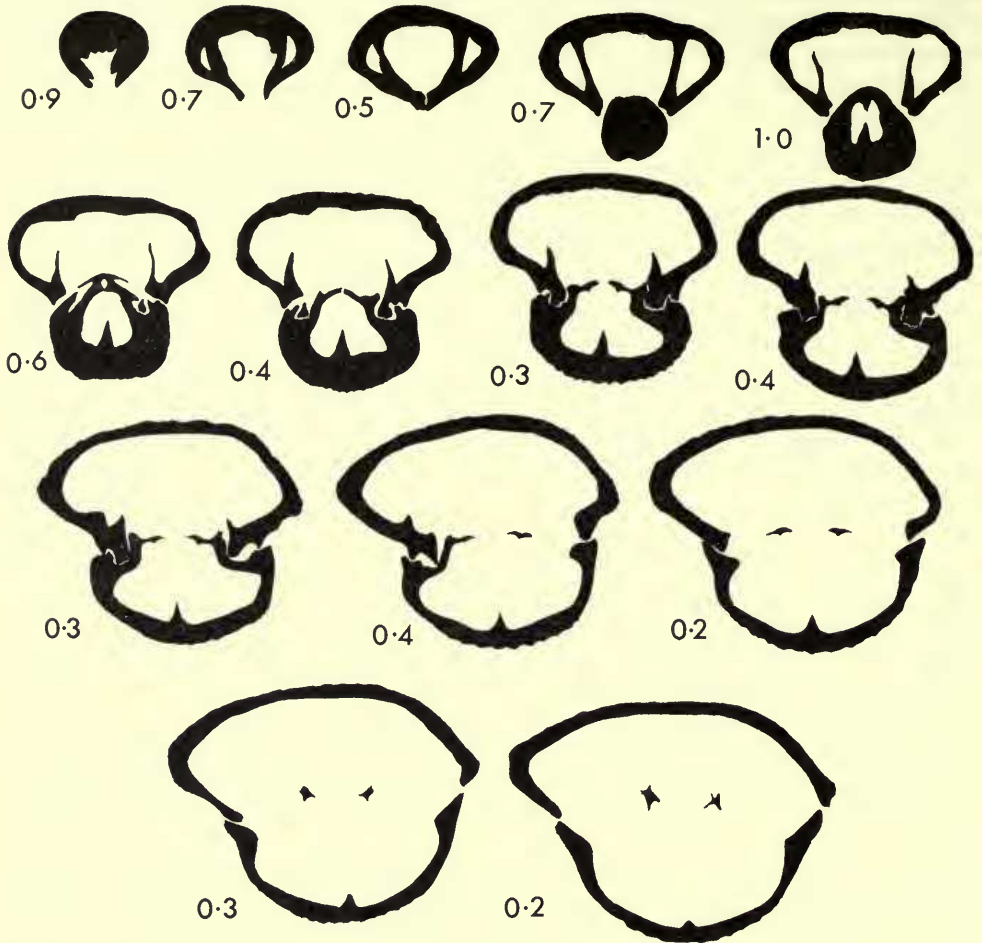


FIG. 4. Another series of fourteen transverse serial sections through the umbo of a specimen of *Lamellaerhynchia rostriformis* (Roemer) from the Neocomian of Gros Vahlberg, north-west Germany. The dorsal septum is shown to be more highly developed and more persistent in this specimen. B. 35703.  $\times 2$ . Numerals denote distance in millimetres between each section.

*Rhynchonella multiformis* (Roemer). These resemble typical *L. rostriformis*, and illustrate perfectly the breadth of variation in size and type of costation to be found in this species. They were collected from the Upper Valanginian of the Jura Mountains, Switzerland. The specimen represented by fig. 5 is similar in general outline to extreme variants of the species collected at Gros Vahlberg, north-west Germany, and from the Claxby Ironstone at Nettleton and figured here (Pl. 2, figs. 4, 5). They also represent the species *T. rostralina* which Roemer (1840, pl 18, fig. 7) briefly described and figured from the Hils of Schandelahe and Schöppenstedt, near

Hanover. This form is very often found in association with specimens which grade into the typical form and is here considered to be a variant and, therefore, a synonym of *Lamellaerhynchia rostriformis*.

Another notable variant has been found in zone C<sub>7</sub> of the Speeton Clay and departs from the typical form in its type of costation. The costae are less acutely angular and less incised, giving them a more rounded appearance, but in general outline the shell follows the same morphological pattern as the typical form. A specimen illustrating this type of variation is figured on Pl. 2, fig. 9. It is housed in the Hull Museum and registered as 61/64/9. A similar specimen is in the private collection of Mr. R. Clements of Hull University.

In some smaller variants the dorsal fold appears to be more highly developed, with resulting inflation of this valve. These features are often accompanied by a more massive, truncated umbo, slightly smaller foramen and less extensive interarea in the ventral valve.

In spite of its variability *L. rostriformis* can be readily distinguished from other species of *Lamellaerhynchia*, mainly by its larger dimensions, coarser angular costae in the typical form, massive umbo and extensive interarea. As in the case of many described species of *Lamellaerhynchia*, *L. rostriformis* has a tendency to asymmetrical development of the anterior commissure. It also exhibits marked growth-lines on the shell surface, a feature not particularly well developed in other forms of the genus.

**DISTRIBUTION.** Apart from the English localities of Speeton, Yorkshire and Tealby and Nettleton in Lincolnshire, the species has been collected from the Lower Hauterivian at Auxerre, Yonne, France; Ste. Croix, Switzerland; and Schöppenstedt, Berklingen, Delligsen, Elligser Brink and Gros Vahlberg of the Brunswick and Hanover districts of north-west Germany.

### *Lamellaerhynchia walkeri* (Davidson)

(Pl. 4, figs. 3-8, Text-fig. 5)

1882 *Rhynchonella walkeri* Davidson : 68, pl. 8, fig. 33 only.

1964 "*Rhynchonella*" *walkeri* Davidson; Rudwick : 145, Text-fig. 6A.

**EMENDED DIAGNOSIS.** Shell subcircular to oval in outline, biconvex. Dorsal valve inflated. Fold and sulcus broad and shallow. Twelve to fourteen coarse, angular ribs on each valve. Umbo short, suberect. Foramen moderate to small, hypothyrid. Deltidial plates conjunct. Beak-ridges distinct, interarea broad, extensive.

**LECTOTYPE.** Davidson (1882) figured two specimens. Of these, his pl. 8, fig. 33 is a true representative of the species as it is widely known and was collected from the Claxby Ironstone at Acre House Mine, near Claxby, Lincolnshire. The second specimen, figured as pl. 8, fig. 34, departs from this form in ornament and outline and is not a true *L. walkeri*. It is housed in the Museum of the Institute of Geological Sciences (Geological Survey) and is registered as G.S.M. 110258. It is described elsewhere in this paper as *L. walkeri claxbyensis* subsp. n.



The specimen selected as lectotype is, therefore, that figured by Davidson on pl. 8, fig. 33; it is housed in the Sedgwick Museum, Cambridge and registered as S.M.B.11401.

*Dimensions of lectotype.* Length 18 mm., width 22 mm., thickness 15 mm.

EMENDED DESCRIPTION. In the early growth stages the costation, which is characteristically angular, is already distinct. The curvature of both valves remains constant during development, so that the convexity of the valves is regular right up to the line of the anterior commissure in all but gerontic individuals, in which further growth produces a flattened anterior aspect. The low median fold on the dorsal valve and the shallow sulcus in the ventral valve both develop late and gradually become differentiated from the flanks.

The adult shell is unequally biconvex, approaches an almost spherical outline, and is ornamented by strongly-developed, coarse, angular ribs. There is some variation but the typical form maintains an average length of 16 mm., width of 19 mm. and thickness of approximately 12 mm.

The dorsal valve is strongly convex, becoming increasingly gibbous in the region of the fold which may be occupied by three or four ribs. The broad shallow sulcus in the ventral valve usually develops two or three ribs. A well-marked growth-line is often visible just anterior to the umbonal region, at a point approximately 2-3 mm. from the apex. Otherwise growth-lines are marginal and tend towards lamellar development in older individuals.

*Internal characters.* These are consistent with those described for the type species with the exception of a somewhat more acute deflection of the hinge-plates towards the floor of the dorsal valve. The broad, concave ends of the radulifer crura are typical.

DISTRIBUTION. *Lamellaerhynchia walkeri* occurs in the Claxby Beds of Lincolnshire, where it is not common. It also occurs in the Neocomian of north-west Germany. Two examples are figured here. Pl. 4, figs. 7, 8 from the Hauterivian of Elliger Brink for comparison with examples from Claxby Ironstone localities.

REMARKS. The degree of variation exhibited by this species is not great and is confined to the coarseness and small number of ribs which are seen throughout all stages of growth, deeply incised on the surface of each valve. The general outline, which is subcircular in the typical form, varies only slightly, becoming more elongate-oval in some and perhaps faintly triangular in other variants. Although no other British Cretaceous species could be easily confused with *L. walkeri* there are other forms which approach this species in general morphology. They differ in their more numerous, less acutely angular ribs, less convex valves and more highly-developed median fold on the dorsal valve.

*Lamellaerhynchia walkeri claxbyensis* subsp. n.

(Pl. 3, figs. 3, 4)

1882 *Rhynchonella walkeri* Davidson : 68, pl. 8, fig. 34 only.

DIAGNOSIS. Oval to subcircular in outline. Umbo short, suberect. Foramen small. Beak-ridges well marked; interarea broad, short. Median dorsal fold well developed. Costae sharp, undivided. Growth-lines marginal.



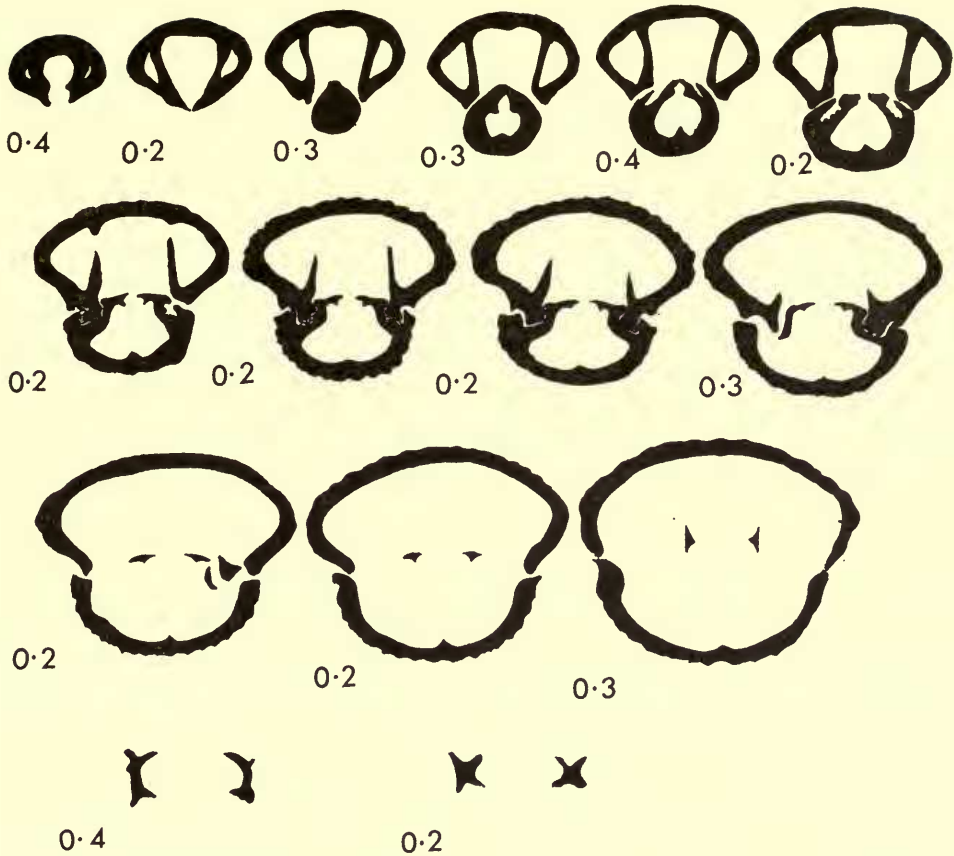


FIG. 5. Fifteen transverse serial sections through the umbo of a specimen of *Lamellaerhynchia walkeri* (Davidson) from the Claxby Ironstone, Nettleton, Lincolnshire. The last two sections show an enlargement ( $\times 5$ ) of the distal ends of the crura. BB.44456.  $\times 2$ . Numerals denote distance in millimetres between each section.

**HOLOTYPE.** British Museum (Natural History) B.M. BB.42944, from the Claxby Ironstone, Top Mines, Nettleton, Lincolnshire.

*Dimensions of holotype.* Length 18 mm., width 20 mm., thickness 15 mm.

**DESCRIPTION.** Although similar in general outline to *L. walkeri* the new subspecies differs from it in having a more highly developed median fold on the dorsal valve, a shorter umbo, and a considerably smaller foramen. The deltidial plates are not well exposed and the broad interarea is shorter or less extensive than in *L. walkeri*. The costae, typically sharp or angular, are considerably more numerous than in *L. walkeri*, and average eighteen to twenty on both valves with four to five on the fold and three to four in the sulcus. Growth-lines are confined to the margins and often become lamellar. This development is well marked on specimens collected from the Claxby Ironstone at Nettleton (British Museum (Natural History), BB.

42945-51). It is also noticeable in specimens from Elliger Brink in north-west Germany, and one specimen illustrating this character is now figured (Pl. 3, figs. 3a-c).

*Lamellaerhynchia rawsoni* sp. n.

(Pl. 4, figs. 11-15)

DIAGNOSIS. Small *Lamellaerhynchia* about 18 mm. long, 20 mm. wide and 11 mm. thick when fully grown. Distinctly triangular in general outline. Median fold well developed on dorsal valve. Umbo slightly produced, laterally excavated. Deltidial plates conjunct, well exposed. Foramen large, circular. Interarea short, broad, bounded by distinct permesothyrid beak-ridges. Ornament of eighteen to twenty coarse radiating, acutely angular, deeply incised costae. Fold and sulcus with three or four costae.

HOLOTYPE. British Museum (Natural History), B.M. BB.44424, from the Roach Stone of Dalby Park, south Lincolnshire Wolds.

*Dimensions of holotype.* Length 20 mm., width 21 mm., thickness 14 mm.

PARATYPES. BB.44421, BB.44425, BB.42954 and BB.42955.

DESCRIPTION. Although *L. rawsoni* bears a strong resemblance to *L. haueriviensis* Burri (1953), from the Lower Hauterivian of Switzerland, it can be readily distinguished by its fewer costae, less well-developed median fold on the dorsal valve, and slightly greater incurvature of the beak. It also has a well-developed growth-line at approximately 2-4 mm. anterior to the dorsal umbo. In older individuals there is a tendency to lamellar thickening of the margins.

Internal characters. As for the type species *L. rostriformis*.

DISTRIBUTION. In the same way that *L. haueriviensis* Burri is confined to the Lower Hauterivian it would seem that *L. rawsoni* is a species of limited vertical and horizontal range, being found only as a rare fossil in the Lower Barremian, Fulletby Beds, of this country. It has not been identified with certainty from any of the north German deposits though it probably exists in the Barremian of the Hanover area.

*Lamellaerhynchia julenia* sp. n.

(Pl. 3, figs. 6, 7)

DIAGNOSIS. Elongate-triangular *Lamellaerhynchia* approximately 20 mm. long, 19 mm. wide and 11 mm. thick when fully grown. Produced, suberect beak, laterally excavated. Conjunct deltidial plates well exposed. Foramen large, circular. Acutely angular radiating costae, coarse and deeply incised. Interarea extensive. Beak-ridges distinct, permesothyrid. Anterior commissure with marked tendency to asymmetry.

HOLOTYPE. British Museum (Natural History), B.M. BB.42984, from the Lower Barremian, Fulletby Beds of Dalby Park, south Lincolnshire Wolds.

*Dimensions of holotype.* Length 21 mm., width 20 mm., thickness 15 mm.

PARATYPE. BB.42985

DESCRIPTION. The outstanding features of this species are its almost equal biconvexity and its constant eighteen to twenty costae on each valve. It is always elongate-triangular in general outline, varying only slightly in width, with a marked tendency to asymmetry of the anterior commissure. It bears a resemblance to *L. gillieronii* (de Loriol) but differs in its coarser, more deeply incised costae and more constantly elongate-triangular outline. It may, nevertheless, be the British equivalent of that species, occurring in the Lower Barremian, as *L. gillieronii* does in Switzerland. The morphological differences described above and the geographical difference would seem to justify the taxonomic separation accorded here.

*Internal characters.* As for the type species *L. rostriformis* (Roemer).

DISTRIBUTION. Although *Lamellaerhynchia julenia* occurs only in the Lower Barremian, Fulleby Beds in Britain, a similar form, differing only in relative size occurs in north-west Germany at Schöppenstedt, but the exact horizon has not been recorded. Three good examples of this species from Schöppenstedt are in the British Museum (Natural History), B.M. BB.44460-62.

*Lamellaerhynchia* cf. *picteti* Burri

(Pl. 3, figs. 8, 9)

DESCRIPTION. Acutely biconvex *Lamellaerhynchia* with short, massive umbo, suberect beak and short interarea. The beak-ridges are distinct and permesothyrid. Distinctly subcircular in general outline. Dorsal fold incipient or indistinct with fairly shallow but broad sulcus in the ventral valve. The costae vary in number from between twenty and thirty on each valve but there are some variants with slightly coarser costation and a corresponding reduction in number of costae. Most of the specimens ascribed here to this species show a tendency to asymmetry of anterior commissure.

REMARKS. Although this species is compared here to *L. picteti* it is somewhat more circular in outline than the specimens figured by Burri (1956 : pl. 8, fig. 3, pl. 9, fig. 1) but is nevertheless very similar in its type of costation, degree of convexity and general appearance. None of the specimens examined exactly matches those illustrated by Burri and it is for this reason that we have compared our species to the original to give a somewhat broader interpretation.

DISTRIBUTION. Only three specimens of *L. cf. picteti* have been found in Britain so far and these were collected from the Claxby Ironstone at Nettleton, Lincolnshire.

Genus **RHYNCHONELLA** Fischer 1809

*Rhynchonella parkhillensis* sp. n.

(Pl. 4, figs. 9, 10, Text-fig. 6)

DIAGNOSIS. Species of *Rhynchonella* approximately 12 mm. long, 13 mm. wide, and 9 mm. thick when fully grown. Shell biconvex, outline subcynocephalous or

tetrahedral. Brachial valve with angular and prominent median fold containing two or three unbranched, simple, deeply-incised costae; sulcus with one or two costae. Beak-ridges distinct, hypothyrid. Umbo suberect. No cardinal process. Shallow septalium. Dental lamellae strong, subparallel. Radulifer crura.

HOLOTYPE. British Museum (Natural History), B.M. BB.42952, from the Fulleby Beds, Roach Stone of Park Hill, Belchford, South Lincolnshire Wolds. Nat. Grid 28907685.

*Dimensions of holotype.* Length 14 mm., width 14.1 mm., thickness 9 mm.

PARATYPES. BB.52953-55.

DESCRIPTION. In the early growth stages both valves are convex and smooth to within 3-5 mm. from the umbones. At this stage the costae gradually become discernible. A moderately deep sulcus develops and extends posteriorly with a linguiform extension averaging 6 mm. in length. The sulcus tapers gently to form a truncated V-shape. The lateral slopes of the fold are well marked anteriorly, separating the high median portion from the convex flanks, and subsiding completely where the costae arise. The number of costae on the fold varies from two to three. In forms where two costae are developed on the fold, one costa is developed in the sulcus. Likewise, when three costae are developed on the fold, two costae appear in the sulcus.

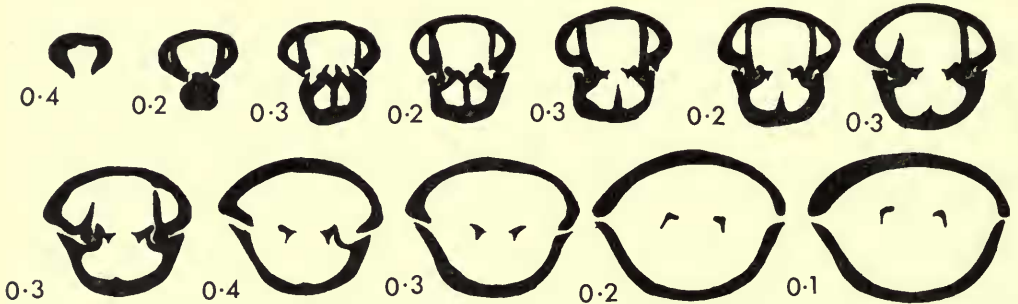


FIG. 6. A series of twelve transverse serial sections through the umbo of a specimen of *Rhynchonella parkhillensis* sp. nov. from the Fulleby Beds, Dalby Park. BB.44405.  $\times 1\frac{1}{2}$  approx. Numerals denote distance in millimetres between each section.

*Internal characters.* Serial sections made from undamaged examples of this species have been compared with a similar series from *Rhynchonella loxia* Fischer, the type species of the genus, published by Ager (1957 : 8, 9). Dr. Ager has kindly confirmed our assignment of the present species to *Rhynchonella* (s.s.).

REMARKS. *Rhynchonella parkhillensis* is named from its most prolific locality at Park Hill, Belchford, Lincolnshire. The species is rare in the Roach Stone over the ten miles of its outcrop. Preservation is rarely excellent, but the paucity of natural exposures and the ferruginous nature of the matrix increase the value of the few specimens which can be found and extracted undamaged.

Superficially, the species bears a resemblance to other species of *Rhynchonella* (s.s.) as re-defined by Ager (1957), particularly to *R. rouillieri* Eichwald, from the



Russian Upper Jurassic. Ager (1957 : 12) discussed the probable relationship of *R. rouilleri* to other species of *Rhynchonella* and assigned it to this genus. The species was further discussed and several subspecies described and figured by Makridin (1964 : 113, pl. 3, figs. 2-12) from the Upper Jurassic of the Russian Platform. Of these *R. rouilleri eltonica* bears a strong resemblance to *R. parkhillensis*, but the latter can be distinguished by its more acute, triangular outline, slightly more highly developed dorsal fold and more produced umbo. It differs from *R. loxia* in having a less acute, cynocephalous outline and more produced umbo but shares with that species the possession of fine, longitudinal striae, just visible on the surface of the shell in well-preserved specimens. These striae are crossed by transverse growth lines, equally faint in development, which give the appearance of a fine reticulation over the surface of the shell.

**DISTRIBUTION.** Apart from the type locality at Park Hill, Belchford, specimens have been collected from the same horizon within the Fulletby Beds at Hoe Hill, Fulletby; Cloven Hill, South Ormsby; Dalby Park and Dalby Hill near Spilsby, South Lincolnshire.

*Rhynchonella speetonensis* Davidson

(Pl. 3, fig. 5, Pl. 4, figs. 1, 2. Text-figs. 7, 8)

1836 *Terebratula varians* Schlotheim; Roemer : 38, II, fig. 12.

1874 *Rhynchonella speetonensis* Davidson : 69, pl. 8, figs. 32a-c.

**EMENDED DESCRIPTION.** Distinctive, subtrigonal, cynocephalous rhynchonelloid bearing a high fold in the dorsal valve at all stages of growth. Although the species is variable it maintains an average length of approximately 19 mm., width of 20 mm. and thickness of 16 mm. The variations are mainly confined to the width, which may exceed the length by as much as 3-6 mm, and the height of the dorsal fold, which is proportionately greater or more acutely arched in some variants.

No costae are developed but the shell is ornamented by numerous fine, rounded costellae, averaging in number from sixteen to eighteen on the fold and fourteen to sixteen in the sulcus. The costellation varies in size and, in some of the German forms from Ellisger Brink, becomes coarse with a considerable reduction in the number of costellae.

*Internal characters.* As in the case of *Rhynchonella parkhillensis* transverse serial sections have been made and compared with those of *Rhynchonella loxia*, as figured by Ager (1957 : 8, 9).

**LECTOTYPE.** Davidson (1874 : 69) described *Rhynchonella speetonensis* from the Speeton Clay of Speeton, Yorkshire and illustrated his description by figuring a specimen (1874, pl. 8, figs. 32a-c) which he said was in the collections of the Woodwardian Museum, Cambridge. In fact, three specimens labelled *Rhynchonella speetonensis*, B.11426, B.11427 & B.11428, from the Speeton Clay are housed in the Sedgwick Museum. Of these, B.11428 is nearest to the somewhat restored drawing of Davidson. It is assumed that all three specimens were used by Davidson and therefore rank as syntypes. B.11428 is selected as lectotype; it is 15 mm. long, 16 mm. wide and 12 mm. thick.



REMARKS. The assignment of this species to *Rhynchonella* (s.s.) was made after due consideration of both external and internal morphological features. *R. speetonensis* has many internal structures in common with *R. loxia*, including strong,

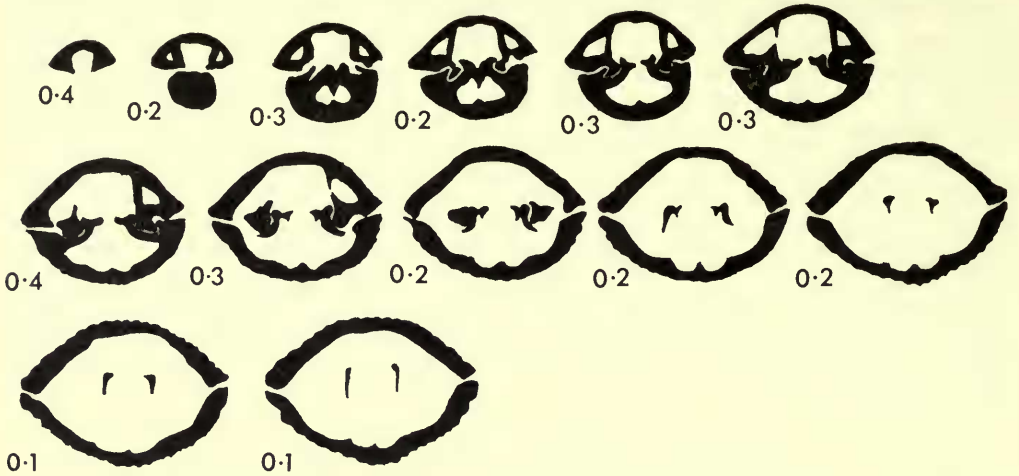


FIG. 7. Thirteen transverse serial sections through the umbo of a specimen of *Rhynchonella speetonensis* Davidson from the Speeton Clay, Speeton, Yorkshire. BB.44458.  $\times 1\frac{1}{2}$  approx. Numerals denote distance in millimetres between each section.

slightly converging dental lamellae, shallow septalium, short dorsal median septum, similarly-shaped hinge-plates, and radulifer crura. Externally the two species have only two main morphological features in common, namely the general sub-trigonal outline and the high cynocephalous median fold in the dorsal valve.

The ornament of fine costellae which distinguishes *R. speetonensis* does not appear on any of the other known species of *Rhynchonella*. However, Ager (1957 : 6) made special reference to faint striae observed on the shell surface of some specimens of *R. loxia*, and noted that Buckman (1918), in discussing the same species, placed sufficient emphasis on this character as to refer to it as capillation. Ager further pointed out that similar fine striae have been seen on specimens of *R. rouillieri* Eichwald from the Lower Volgian of Russia. We have also noted this feature in our description of *R. parkhillensis* sp. n.

In his original description of *R. speetonensis* Davidson (1874 : 69) referred to the numerous growth-lines which cross the main costellation to form a reticulate ornamentation. This is particularly noticeable [see Pl. 3, fig. 5] in specimens from the Speeton Clay but is less well preserved in specimens from the Claxby Ironstone.

The ornament of fine costellae and the high median fold in the dorsal valve, together with a more highly developed or slightly produced umbo, distinguish *R. speetonensis* from all other known species of *Rhynchonella* (s.s.).

DISTRIBUTION. The species appears to be confined to the Speeton Clay (exact horizon uncertain), the Claxby Ironstone at Nettleton, and the Neocomian Beds at Elligser Brink and in the Hanover district of north-west Germany.

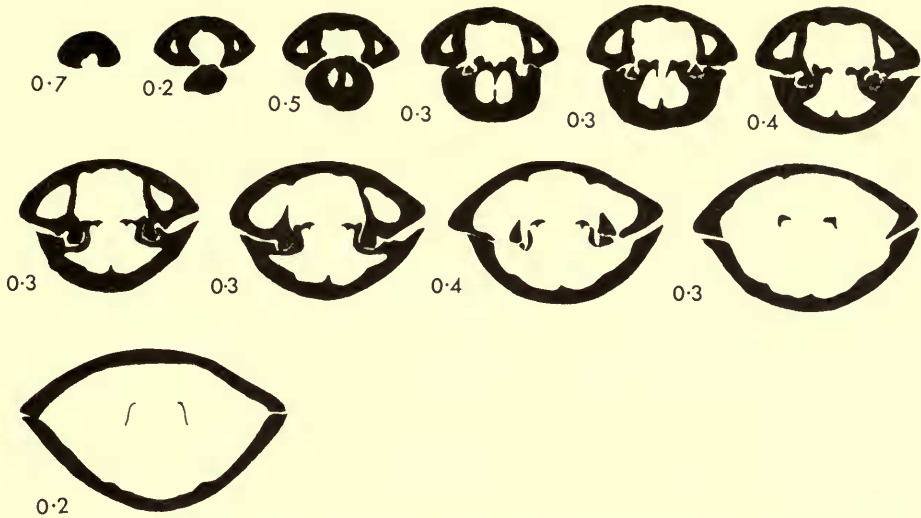


FIG. 8. Eleven transverse serial sections through the umbo of a specimen of *Rhynchonella speetonensis* Davidson from Elliger Brink, north-west Germany. B.11968.  $\times 2$ . Numerals denote distance in millimetres between each section.

#### CONCLUSIONS

Since the early descriptions by Roemer (1836; 1840) the north-west German Lower Cretaceous rhynchonelloid fauna has not been further investigated. The paucity of well-collected material from localities of known geological age has made any attempt to correlate the German species with the British forms from Lincolnshire and Yorkshire difficult. A few species have been recognized as occurring on both sides of the North Sea and one of the most important of these is *Lamellaerhynchia rostriformis* (Roemer). This is a variable form, but an attempt is made here to define the broader limits of its variation and to draw a closer comparison between the north-west German specimens and those collected from British localities. In addition, comparison is also made between British and German forms and those described by Burri from the Neocomian of Switzerland.

Although accepting a wide degree of variation within the limits of the species as defined here, it is pointed out that the precise geological range of *L. rostriformis* is unknown and the data obtained are based on specimens collected from Speeton and Nettleton by Dr. R. G. Thurrell and Dr. P. Rawson, and from museum material.

It is thought that any differences in the internal characters between specimens sectioned by the authors (Text-figs. 3, 4) and those previously published by Burri (1953; 1956) are due, in the main, to differences in the technique of making and of presenting drawings of transverse sections.

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